away, or slide down into the cutting, and the static line or slope formed by the fracture varies with the strata, and according to the nature and cohesion of the particles of earth; for all soils will stand at some angle or inclination peculiar to their character or formation. And when ground is cut into and left unsupported, that at the sides will not cease to crumble and slip until the lateral forces become destroyed, or until the power of cohesion and friction of the ground be in equilibrio with the forces acting upon it, the soil having then attained its natural slope, which is the angle of repose.

The earth contained within the triangular prisms on each side of the trench of a sewer, becomes detached in consequence of the natural or re-acting support being withdrawn by the cutting, and by the force of gravity each prism has a tendency to slide down the planes of natural inclination. These bodies of earth, therefore, in all cases require to be supported, for which purpose it is essential that the resisting force be somewhat greater than the pressure, for if the latter predominate, the structure will either be displaced or thrown down. From it being necessary to construct sewers at considerable depths in the ground, it is essential that they be of a form capable of offering a powerful and efficient resistance to both lateral and vertical pressures; but these are liable to much variation, being dependant upon the nature and compactness of the earth, and the angles at which they will stand.

It is desirable, therefore, that the walls of a sewer be arranged so that the lines of pressure fall within their substance, and not to touch the intrados; for if the pressure from the ground at a side be so great that its direction touches the interior surface of the wall placed against it at any point, nearly the whole of such pressure becomes concentrated, and acts at that point, and if the resistance of the wall be not greater than the pressure it will yield, and be forced from its position. For when a body is subjected to the pressure of another body, the conditions of equilibrium require that the reaction afforded by the former be equal and in an opposite direction to the pressure of the latter, otherwise motion will ensue.

Reclining curved walls, whose bases abut against each other, are considerably stronger for the bottoms and sides of sewers, and afford greater resistance to lateral pressure than walls that are built upright, at some distance apart, and parallel to each other. *For according to the well known principle of mechanics, that when a body at rest sustains another body by one or more forces acting at given points, the re-action of the forces will be in directions perpendicular to those points, or to the surfaces of contact, and these perpendiculars must meet either at the centre of gravity of that body, or in the vertical line which passes through it.*

Now, according to the foregoing principle, it is easily ascertained, by trigonometry or the compositing and resolution of forces, that the rectangular wall, compared with the curved wall, has nothing like the same resisting power to counteract the pressure from the ground, consequently it would be overturned or slide off its bed where the other would remain uninjured. Hence the necessity for adopting the curved form for the side walls of sewers in order to ensure strength, durability, and adequate resistance to lateral pressure. And where ground is of a clayey or slippery character the greatest pressures arise from that adjacent to the sides, therefore it is at those parts the greatest resistances should be placed, otherwise the walls must of necessity give way and be forced off their seats into the sewer. The quick curved form of the ground itself under the invert and sides, assists very considerably in preventing that above from becoming displaced, and when the ground is liable to slip, this form keeps the line of fracture of the ground much higher, or causes the force from it to act where the sewer has the greatest power of resistance, namely, across its broadest part, or where there is most curve; and the inclination of the ground, as also the side walls, should be as obtuse as possible, as then these are better able to resist the lateral pressure. The greater external periphery of curved walls prevents them from being fractured by the pressure of the ground acting against them; for as the radiating joints form an angle with the horizon, when lateral pressure is so great that the wall is liable to be displaced, that portion of it above the line of fracture must be lifted upwards off its bed, while a rectangular wall, under the same pressure, would be forced forwards.

From their superior strength in resisting pressure, battering curved walls are always adopted for retaining walls where stability and sound construction is sought for. And there being a direct similarity between ground pressing laterally against a sewer and that pressing against a retaining wall, it is evident that in order to afford the greatest resistance with the least consumption of materials, curved side walls for sewers are of necessity the best and strongest; besides, the arch thrown across them form abutments which afford forcible counteracting resistances to the pressures from the ground at the sides. Another great advantage of battering curved walls is, that when the ground at either side has a tendency to slip, before it can do so it must upheave the side wall and the arch, with the ground upon it, the whole mass turning round like a hinge at the point of fracture, while a rectangular, or slightly battering straight wall would collapse or be forced forwards off its seat with much less pressure.

The ground adjacent to sewers, as well as that on the top of them, forms their *natural abutments*, for the pressure from one side re-acts against the pressure from the other, and the super-imposed weight on the crown counteracts the pressures from both sides, and thus the lateral pressures prevent that on the arch from forcing *it downwards*, and the side walls *outwards*; and the pressure of the arch and the load upon it prevents those from the sides forcing the side walls *inwards* and the crown *upwards*, and, therefore, when the sewer is of a proper form it is then capable of effectually resisting those pressures; provided the ground be properly excavated for the bed, the brickwork soundly executed and built to the proper curvature, and the walls efficiently protected by the returned ground being well and soundly rammed down around them, as then the sewers and the earth adjacent to them will be in a state of equilibrium with each other.

Under scarcely any circumstances should rectangular or straight battering walls enter into the construction of sewers, because, from being exposed to very great external pressures they are liable to be forced off their seats and to crack or collapse at the points of fracture, that is where the lines of pressure touch the inside of the sewer; and the resistance afforded by rectangular walls is dependent upon their own weight, the load upon them, and the cohesion and friction of the joints where the pressures act, consequently the effect of pressure at any point would be to cause the walls either to slide or turn round on an axis; and their power of resistance is merely that of *extension* only, whereas curvilinear brick walls are made up of a series of wedges, which tend to a central point, and contain outside the neutral axis a greater amount of material than there is inside of it, and which must be *compressed*, whilst the lesser quantity of material inside the neutral axis must be *rent asunder or extended* before the walls can give way, that is when the external pressure is equal at every part. Therefore the curved form not only affords greater resistance but bears transverse strains much better than rectangular walls, and consequently are better adapted to support earth, and that too with much less quantity of material because the perimeter of a circular wall is much less and contains within its circumference a greater area than that of any polygonal or rectangular figure. It would add much to the strength and durability of sewers were radiating bricks used in their construction instead of rectangular bricks, as bond could then be produced which would tie the walls together transversely much better than is done with half-brick rings and heading courses, when these can be got in. The expense of making and burning this description of brick would not be more than 3s. or 4s. per thousand above the cost of common rectangular bricks, and were a large order given, the cost probably would not be more than 2s. 6d.

The crown of a sewer with the weight of the superimposed ground, together form a great connecting link to the stability of the side walls, by enabling them from the increased weight thrown on them to sustain with greater security the ground at the sides. The weight of the ground on the arch is almost always sufficient to prevent the pressure at the sides from upheaving or disturbing it; but when the arch is too flat the pressure upon it will force the side walls outwards *if these be not properly protected*. And again, if the arch rise too much, the lateral pressure will cause it to collapse at the sides or springings, and it will crack and rise upwards at top, but the pressure upon the arch is almost always sufficient to prevent this from occurring. A semicircular crown for a sewer appears to be a mean between that which is too flat and that which is too high. But the semicircle is not the best form for supporting vertical pressure, for it has a considerable tendency, when the ground is not sufficiently firm or compact, to sink at the top and rise or spread at the haunches; and I have noticed that a great many arches of sewers of a semicircular form have gone exactly in this manner. Under these circumstances, therefore, I think it is desirable to make the arch or crown of a sewer somewhat of an elliptical shape, with the longer axis upwards or approaching to the form of the equilibrated arch, as then the lines of pressure from its weight and the load upon it, are distributed more equably within its substance, and the resistance that this pressure affords is then thrown where it is mostly required, namely, across its broadest part; besides, by giving the arch this form, an opportunity is afforded for making the side walls more obtuse and of greater curvature, which greatly improve their power of resistance.

It is considered that a form of sewer which is suitable for one locality is not adapted for another. This principle holds good only where ground differs considerably in its character; and attention need not be paid to it except on extraordinary occasions. Greater width and lateral resistance is needed where ground is very soft, clayey, or of a slippery nature, when it is desirable to conform to the shape of the circle; for a cylindric ring under every condition is the strongest form for resisting transverse pressure when it is equally divided around it. But the circle, although it is the strongest, is not the best and most efficient form for a sewer, as other conditions besides strength are connected with the subject; for the whole object of sewerage is to effect in a speedy manner the discharge of the drainage. Whatever may be the character of ground through which a sewer has to pass, its form should never depart from the principle of the arch whose properties should be the genises on which to design every hollow structure that is to have pressure acting around it.

In performing the practical operations of sewer work, it is essential that great pains should be bestowed upon the excavation of their bottoms. For in order that the brickwork of the invert may be constructed to the proper curvature, it is extremely desirable that the bed of the sewer should be brought as near to the form of its outer periphery, and as correct as it is practicable to make it.

The discharge of drainage and sewage is wholly dependant upon the velocity, inciting force and energy of flowing water, which must in all cases have sufficient power to overcome the inertia or force of gravitation of the sewage matter, as also to sweep and carry it forward in mechanical suspension. Now the greatest amount of velocity and impelling force to which a descending stream, with a given inclination, can attain, depends on the least width of the development of the surface of contact; it is therefore of the greatest importance always to make the channels of sewers of a shape conformable to that which produces the utmost velocity and the least amount of friction or rubbing surface for the water to flow in. I shall hereafter proceed to examine the forms, arrangement, and construction of sewers with reference to this all-important point.

THE WROUGHT NAIL TRADE.—The workmen of this trade, upwards of 15,000, made a stand last week for an advance of 10 per cent. upon their wages. Messrs. Caddick, of Coseley, at once told their workmen they would give it to them, and that they must not stand a single hour. Messrs. Caddick paid them the advance on Saturday last, and stated they hoped in a short time to be able to give a further advance.

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